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A Multi-level Model of Moral Thinking Based on Neuroscience and Moral Psychology

Changwoo Jeong
Seoul National University, Seoul, South Korea

Hye Min Han
Stanford University School of Education, Stanford, USA

Developments in neurobiology are providing new insights into the biological and physical features of human thinking, and brain-activation imaging methods such as functional magnetic resonance imaging have become the most dominant research techniques to approach the biological part of thinking. With the aid of neurobiology, there also have been several studies on the biological processes of human moral thinking in moral psychology. For instance, some researchers have tried to discover patterns of brain activation when a person copes with moral dilemmas. In this paper, the authors suggest the level-structure of moral thinking from the most abstract level to the most biological-physical level and reductionism in the philosophy of science is introduced as a framework for analysis. Moreover, with the level-based structural approach and framework of reductionism, this paper tries to discover the practical value of our model for moral development and education.

Keywords: moral thinking, moral psychology, moral development, neuroscience, reductionism, philosophy of science

Introduction

Developments in neuroscience and imaging technology have led to new discoveries in how the brain is activated. For instance, fMRI (functional magnetic resonance imaging) enables us to understand which part of the brain is activated when it is stimulated by outer sensory signals. Moral psychology, which investigates human functioning in moral contexts, is also affected by new trends in technological advancement (Narvaez & Vaydich, 2008). Several leading scholars in moral psychology have studied the relationship between moral psychology and neuroscience to find applications of the new technologies to the field of moral psychology. Narvaez (2008) suggested the triune ethics theory, which deals with how the structure and wiring of the brain influence preferences, affordances, rhetorical susceptibilities and other factors. Robertson et al. (2007) used fMRI to study the neural processing of moral sensitivity to issues of justice and care by finding the difference in the activated area of the brain when subjects were confronted with different dilemmas.

These studies that tried to show neuroscientific mechanism of moral functioning, such as the relationship between moral thinking and brain activation, contributed to widening our biological and neuroscientific knowledge about moral functioning and moral development. However, the studies do not seem to take note of the philosophical basis of links between moral functioning and brain activity. Specifically, there exist few explanations for how abstract, mental functioning can be implemented on physical, biological structures and

Changwoo Jeong, Ph.D., associate professor, Department of Ethics Education, Seoul National University.
Hye Min Han, Ph.D. candidate, Developmental and Psychological Sciences, Stanford University School of Education.

what factors exist and work between those two heterogeneous layers.

To cope with this problem, this paper will suggest a multi-level model of moral thinking through the link between neuroscience and moral psychology, from philosophical and practical viewpoints. For the purpose, the study will analyze the relationship between moral psychology and neurobiology through the adoption of the overarching concept of reduction from the philosophy of science. Debates about reduction/reductionism in philosophy provide new insights in the understanding of the structure of human thinking in general and, particularly, moral thinking. Moreover, with the level-based structural approach and framework of reductionism, this study tries to discover the practical value of our model for moral development and education.

Reduction/Reductionism in the Philosophy of Science

Reductionism is the view that things in the universe are arranged hierarchically and causation only occurs at the lower levels of this hierarchy. Reductionism entails a relationship between parts and wholes such that wholes are explained in terms of their parts, hence, a reductionist focuses on describing and attempting to understand a phenomenon in terms of its parts (Fher, 2006).

From the view of the relationship among theories in natural science, reductionism is taken to imply that if physics (which deals with more fundamental entities than chemistry or biology) could do the work of chemistry and biology, then there would be no need for chemistry and biology. Similarly, physical chemistry is the application of physics to macroscopic, microscopic, atomic, subatomic and particulate phenomena in chemical systems within the field of chemistry traditionally using principles, practices and concepts of thermodynamics, quantum chemistry, statistical mechanics and kinetics (Atkins & Paula, 2006; Levine, 2007). A basic view is that physical chemistry deals with the physical and more reduced basis of chemistry.

With respect to scientific research, if you study living systems, reduction means to study the particles (molecules, cells, etc.) of such systems—to go down the scale from organs to cells and to molecular compounds. Thus, modern science cannot renounce this kind of methodological reduction. Furthermore, with respect to methodology, every scientist may be regarded as a reductionist in the sense of restricting himself/herself (at any particular moment) to only certain aspects of reality and of generally attempting to find unity in diversity. In short, it is believed that science will prefer a reductive approach, which is a part of the method that makes science distinguishable, since most fields in science try to explain something in bottom-up manner and find more elemental, underlying principles in phenomenon (Turner, 2001).

For this reason, even though we can acknowledge that reductionist methods are powerful and are one of the reasons that science is so successful, reduction has many limitations and is criticized simultaneously. The critique by Anderson (1972) would be most notable in the argument that the sciences roughly can be arranged linearly in a hierarchy as particle physics, many body physics, chemistry, molecular biology, cellular biology, physiology, psychology and the social sciences. The elementary entities of one science obey the laws of the science that precedes it in the above hierarchy, as it recognizes the existence of reduction in the sciences. This does not imply that higher-level science is just an applied version of the science that precedes it, as it insists that at each stage, entirely new laws, concepts and generalizations are necessary. Understanding a science of a higher level requires a similar amount of inspiration and creativity required for understanding a science of a preceding level.

There are critics that present practical limitations. Van Regenmortel (2004) and Alm and Arkin (2003) insisted that the constituents of a complex system, such as bio-organisms interact in many ways, including

feedback control that leads to dynamic features that cannot be fully predicted by linear or ordinary mathematical models. It is possible to understand this complexity practically. The higher systems might be divided into more elementary parts at lower stages. However, in the complexity of dynamic systems, such as biological organisms, there is a need to sacrifice simplicity and the convenience of explanation.

Therefore, we work within and sometimes over a methodological view of reductionism, because reductionism is not sufficient to explain and understand complex phenomena, but we cannot renounce methodological reduction as a strategy in scientific research.

Reductionism, Mind, and Moreover

Churchland (1987) showed that cognition is not neatly detachable from the ecological niche, way of life and bodily structure. The human nervous system is not a general-purpose computer, as it has evolved to accomplish a certain range of tasks and its architecture supports those tasks. Churchland (1987) suggested a general strategy in connectionism to explain cognition, as it is to model the information processing in terms of the trajectory of a complex and nonlinear dynamical system in very high dimensional space. The model resembles a neural network system that depicts the neuron system of an organism.

A general neural network consists of a set of neurons that are logically arranged into two or more layers. The network has an input layer and an output layer so that each contains at least one neuron. Neurons in input layers are hypothetical in that they do not have inputs and they do no processing of any kind. Their activation-output is defined by the input of the network. There are usually one or more hidden layers between the input and output layers. The information flows in the one direction of “feedforward”. Output layer errors that are the difference between the expected results and the real result successively propagate backwards through the network. This backward propagation changes the weights of the internal neurons to minimize further errors (Masters, 1993).

This neuro-learning idea is similar to the psychological model of cognition suggested by Piaget (1931; 1955; 1960), who said that intelligence progresses from a state in which accommodation to the environment is undifferentiated from the assimilation of things to the subject’s schemata to a state in which the accommodation of multiple schemata is distinguished from their respective and reciprocal assimilation. Assimilation denotes a process by which a person takes material from the environment into their mind and changes their sense of the incoming evidence to make it fit into his/her mind. Accommodation refers to the difference made to one’s mind or concepts by the process of assimilation. Assimilation and accommodation go together (Atherton, 2005). An individual framework of cognition deals with the outer world and helps it accommodate the experiences from the outer world. This is similar to the process of the neural network as both of them minimize the error, gap or conflict between the internal system and the outer reality.

Piaget (1979) linked the view of cognition with cybernetics, which is defined as “the science of control and communication in the animal and the machine”, and its theme is based on coordination, regulation and the control of biological and practical interests (Ashby, 1999). Piaget (1979) insisted that the positive and negative feedback of regulatory modulations of cybernetics theory would have a relation with his model. It showed that cybernetics enriched psychology with new models that make interpretations possible based on equilibrium and moving to higher level equilibrium without degradation. Psychology would supply cybernetics with factual examples of more complex models of self-organizing systems. This relationship between the higher cognition model and the cybernetic model would be similar to abstract problem-solving methodology and concrete

algorithm. It can be related to lower and reduced levels that deal with physical basis of human thinking.

Piaget (1979) sought the relationship between psychology and biology and noted that there is feedback from behavior to the details of the organization of the brain and nervous system. He foresaw that causal explanations from psychology can be enriched with central mechanisms that biology studies. Piaget's model of cognition sought to explain the model of human cognition including biological mechanism. The lack of neurobiological discoveries in the era of Piaget hindered the connection from being made between cognition and the part of the brain that activated thought.

From discoveries in medicine and engineering, we are able to see what the activated part of our brain looks like. An fMRI, for example, detects changes in blood oxygenation and flow that occur in response to neural activity. When a brain area is more active, it consumes more oxygen, and to meet this increased demand, blood flow increases to the active area (Devlin, 2005). The use of fMRI is increasing because of the advantage it has of allowing the non-invasive localization and measurement of brain activity (Heeger & Ress, 2002). However, in fact, there are several critics on fMRI applied researches: (1) The exact relationship between the measured fMRI signal and the underlying neural activity is unclear; (2) Strong magnetic field cannot be fully homogeneous; and (3) There are great amount of noises interfered to electric signals, so the fMRI signal is only an indirect measure of neural activity (Logothetis, Pauls, Augath, Trinath, & Oeltermann, 2001).

In the problem-solving field of moral psychology, the application of fMRI research techniques is also increasing. There are several studies on the roots of morality. For instance, neuroimaging studies have linked several brain regions to moral cognition. They found that disruptions to the right temporoparietal junction, which is involved in understanding intentions, or the ventromedial prefrontal cortex, which processes emotion, have been found to alter moral judgments (Miller, 2008). With the aid of neuroimaging methodologies, such as fMRI, it is possible to see the functions of our brain and study human morality from a neurobiological viewpoint.

Structural Levels of Moral Thinking—With a Biological Structure

The relationship between the mind and its biological structure is explained with multi-layered models of the brain process. Marr and Poggio (1976) suggested a model of the individual levels of the brain processes, such as computational vision (see Figure 1). The levels include: (1) the computational level that analyzes what problem is being solved and why, and investigates the natural constraints that the physical world imposes on the solution to the problem; (2) the level of the algorithm, specifying a formal procedure to perform the task by providing the correct output for a given input; and (3) the level of physical implementation of the algorithm by some mechanism or hardware (Marr & Poggio, 1976; Poggio, 1981; Churchland & Sejnowski, 1988).

This paper suggests the three-leveled model that consists of abstract problem analysis, algorithm and physical basis in moral functioning, following Marr and Poggio's idea.

Abstract Problem Analysis of Moral Thinking—First Level

The highest level of Marr and Poggio's model, the computational level of abstract problem analysis, is linked to the notion of moral judgment as the conceptual level model of reason and emotion that makes practical moral decisions. The major models of moral processing by humans would be the computational level of abstract problem analysis as shown by Kohlberg (1981), Rest, Narvaez, Thoma, and Bebeau (2000) and Blasi (1983).

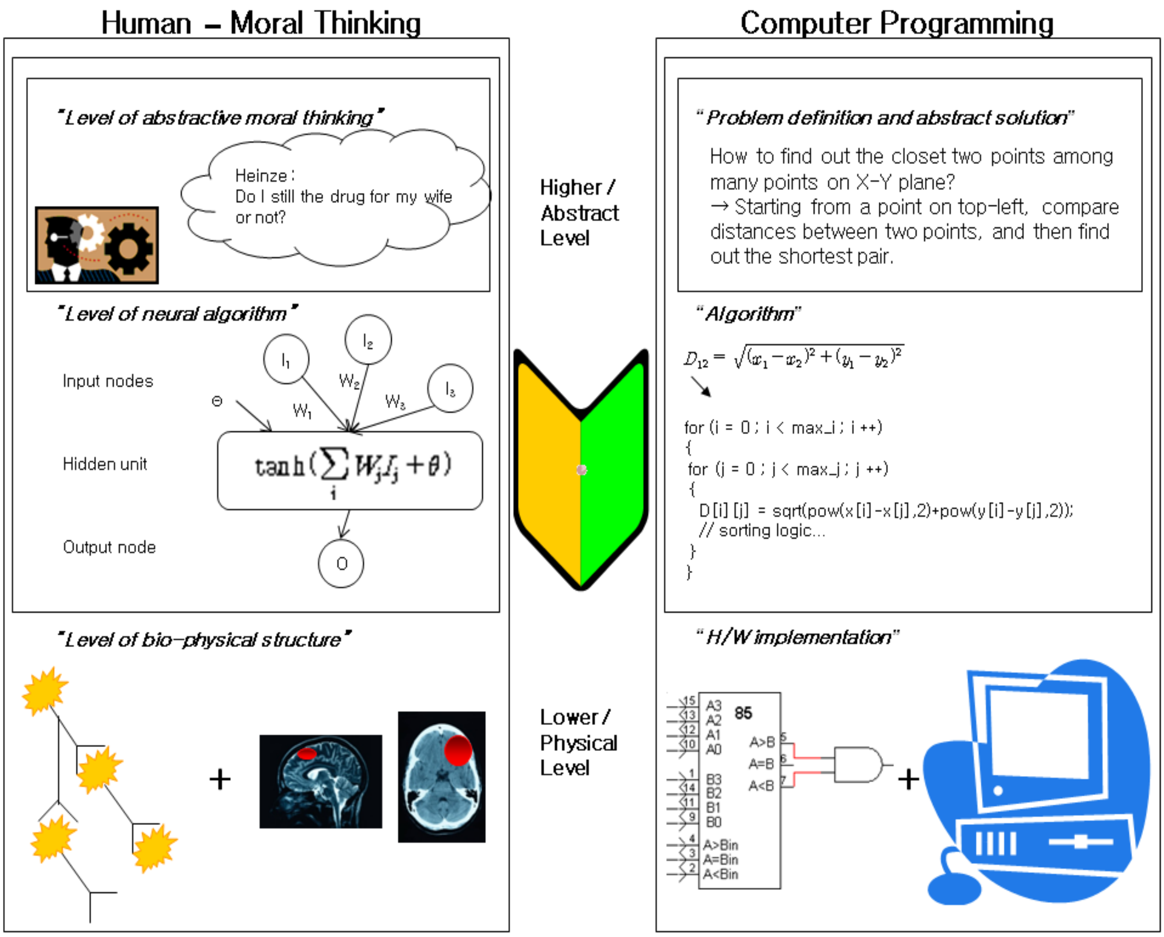

Figure 1. Levels of moral thinking of human and computer programming.

Moral stage development, in Kohlberg's (1981) model, requires the attainment of cognitive- and perspective- taking prerequisites together with exposure to appropriate experiences of cognitive disequilibrium (Walker, 1988). Developing upward through the various stages, one's reasoning is increasingly concerned with others' needs and less exclusively with one's own. There is a development in capacity to deal with the increasing cognitive complexity and abstraction required to comprehend the reasoning of each successive stage.

Rest's initial introduction to moral reasoning theory was based on Kohlberg's work (Rest et al., 2000). Distinctions between Kohlberg's theory and the neo-Kohlbergian schema used by Rest, Narvaez, Thoma, and Bebeau (2000) center around Rest's argument that it is more appropriate to consider the percentage of an individual's reasoning at a particular stage of development rather than whether a person is "in" a particular stage. Thus, Rest referred to the development process as schemas (soft, more permeable stages) rather than hard stages, as Kohlberg proposed (Rest et al., 2000).

In Blasi's (1983) self-model, morality becomes an integral part of personality when moral understanding and concern (which are foundational) become a significant part of one's identity. His model is premised on the notions that moral knowledge and moral judgment have inherent motivational force (given its truth value) and that a basic motive of personality arising from a moral identity is consistency between understanding and action (Matsuba & Walker, 1998).

The most popular models that explain how people are being morally are reviewed and those models relate

to the psychological studies of moral psychology. Those models can help explain how people are being morally and how to educate people to be moral. It would be very useful, if those models were concrete, but the models do not deal with a concrete processing flow of the mind or physical basis as they just depict abstract architecture and relationships among factors and how they work at an abstract level. This situation is similar to computer programming.

Algorithm of Moral Thinking—Second Level

The second level of Marr and Poggio's (1981) model, the level of algorithm, deals with inputs and outputs related to the neural network model. As seen from work of Masters (1993), inputs receive stimuli from outside of former output nodes, amplify the signal with internal weights and transmit the amplified signal to nearby connected nodes. Hidden layers receive signals from former nodes, calculate them with the weights and transfer them to the next hidden layers or output layers. Lastly, output nodes receive output from the calculations and compare them to expected results and then errors feedback to former layers and a neural network trained to approach towards global minima that minimize the errors (Alspector, 1988; Bhadeshia, 1999).

Churchland (1998) suggested a cognitive neurobiological approach towards moral virtues. He reconstructed moral cognitive phenomena in cognitive neurobiological terms of the activities of neurons. In this interpretation, moral knowledge was explained as a vast configuration of appropriately weighted synaptic connections so that moral discrimination also resides in an intricately configured matrix of synaptic connections. There is an explanation of moral learning, perception, character and other moral factors with the connection to the training and functions of neural networks.

In this study, Churchland (1998) suggested an algorithm of how moral cognition works, but did not locate the particular parts of the brain or nervous system that work in the understanding of moral problem. Moreover, this study did not deal with the mind and problem-solving at a physical level. The study modeled problem-solving methodology in the way of the training of neurons and synapses and working against outer circumstances and stimulations. The cognitive neurobiological approach towards moral virtues proposed by Churchland (1998) in the study worked with an abstract space of a motor-neuron activation pattern and not with a concrete-physical mechanism of neurons. To study the "core of, lowest level of" moral thinking, there is a need to work with several tools that examine the brain, such as fMRI.

Physical, Biological Basis of Moral Thinking—Third Level

The physical basis is related to the brain and nervous system. This level can refer to contemporary studies of neurobiology that seek the relationship between human thinking and the biological mechanism of the brain and neural system. Studies related to moral functions of the brain or nervous system can be included in approaches to the level of anatomical, medical, or fMRI related research.

Casebeer and Churchland (2003) showed what parts of the brain deal with moral cognition for moral judgment and decision-making from the lowest level part of the mind. They studied what parts of the brain work with moral problem-solving at a physical level but not at abstract level. They explained the mechanism of moral thinking in the brain from the function of the prefrontal cortex that is a part of the frontal cortex, which lies anterior and medial to the motor and pre-motor cortex.

The functions of prefrontal cortex are critically dependent on limbic structures that consist of the amygdala, the cingulated cortex and hippocampal structures. The amygdala is identified as crucial for aversive

conditioning and negative feelings, such as fear. It plays an important role in recognizing a situation as fearful and for realizing a fearful expression and seems that the amygdala is particularly critical for making appropriate moral judgments about visual stimuli. The cingulated cortex, especially the anterior regions, does the regulation of selective attention, regulation of motivation and detection of mismatches between intention and execution.

Casebeer and Churchland (2003) explained what parts of the brain cope with moral problem-solving. Greene, Sommerville, Nystrom, Darley, and Cohen (2001) examined how emotions engage in moral judgment. In this study, they used fMRI to locate what part of the brain activates when we exercise moral judgment or make moral decisions. The study divided several kinds of problems into three categories: up close and personal-emotional problems, impersonal-less emotional problems and non-moral problems.

The fMRI experiment showed that brain areas that deal with emotion were more activated in the personal-emotional problem than in the other conditions. Areas associated with working memory have been found to become less active during emotional processing, as compared to periods of cognitive processing. Some areas of the brain that are associated with working memory were significantly less active in the moral-personal condition than in the other two conditions. Other areas showed no significant difference between the moral-impersonal and the non-moral condition.

Moreover, Greene and Haidt (2002) arranged several brain regions and the associated moral tasks. With those relationships, they found that social pathologies were linked to damage of those parts. First, personal moral judgment involves the medial frontal gyrus (Brodmann Area 9/10), posterior cingulate, precuneus, restrosplenial cortex (BA 31/7), superior temporal sulcus and inferior parietal lobe (BA 39). Second, the impersonal moral judgments are related to BA 9/10, BA 31/7, the dorsolateral prefrontal cortex (BA 9/10/46) and the parietal lobe (BA 7/40). Third, simple moral judgments activate BA 9/10, BA 31/7, BA 39, BA 10/11 and the temporal pole (BA 38). Fourth, viewing moral pictures is related to BA 9/10, BA 31/7, BA 39, BA 10/11 and the amygdala. Lastly, forgivability judgment is associated with BA 9/10 and BA 31/7.

From the study of Churchland and Sejnowski (1988) to that of Greene and Haidt (2002), the results of these studies showed how the brain works with different kinds of moral problems and what parts of the brain are activated. This provides further knowledge on the mechanisms and structures of the lowest and physical level of moral thinking.

The Structural Model of Moral Thinking—With an Analogy to Computer Organization

For better understanding of the multi-level model, an analogy between the model and the computer organization will be presented. The structure of a computer, arranged from the highest level to the lowest level, came from our usage of the computer. We can put the most abstract level of computation to this structure. When we want to solve a problem using the computer, generally, we do the “programming”. This first requires an understanding to find out the methodology for problem-solving. In this level, the descript input and processing of data are needed. The necessary directions must be understood in order to plan or outline the big picture of problem-solving (Brooks, 1999). Outlining the big picture of problem-solving is an abstract task, not a concrete task, and at this level, there is the most abstract plan and process of problem-solving. A person depicts the necessary process into the abstract form (such as a flow chart) to find the required input and output.

If the highest level is the most abstract one, the second level would be more concrete than the higher one.

In this level, the term "algorithm" may refer to any well-defined computational procedure that takes some value (or set of values) as input and produces some value or a set of values as output. Also, the algorithm describes a specific computational procedure to archive the relationship between inputs and outputs (Corman, 2003). An algorithm is a finite set of instructions to accomplish a particular task (Pandey, 2008). The abstractive level includes procedures of problem-solving but does not include a concrete solving process like an algorithm. An algorithm includes possible solving processes that are expressed in computational instructions, such as a mathematical formula.

The lowest level, physical basis, is related to the hardware and electric parts of computation, although the higher two levels do not deal with a "real execution" of the solution and do deal with the "modeling and expression of the solution". This level is related directly to reality. The logics are translated into binary digits or bits (0 and 1) that are related to the "on and off" of electrical signals, which can be directly processed by the machine (Farrell, 2002; Patterson, Hennessy, Ashenden, & Laurus, 2004).

The levels of a computational model, the level of abstractive ideas of problem-solving, the level of formulated algorithms and the level of physical basis on computers have been reviewed. The hierarchical model of moral thinking will be compared with the hierarchical model of computation. First, the highest level of moral thinking, the abstract framework of moral psychology, such as the model by Rest et al. (2000) or Blasi's (1983) problem-solving would be linked to the abstract model of problem-solving in computation. This level only deals with the abstract, overall mechanism of moral thinking-higher cognition, which does not cope with actual, concrete processes of formulated neural algorithms and is not rooted in the neuroscience of morality (Greene, 2005; Narvaez, 2008).

The second level of moral thinking, the neural network modeling, would be related to the level of algorithms of computation, because the neural network can depict the actual procedures of thinking. When the network is executed, a neuron calculates the activation value by taking the weighted sum of the outputs of the units in the preceding layer. The activation value produces the output of the neuron. When the entire network has been executed, the outputs of the output layer act as the output of the entire network (Kröse & van der Smagt, 1996; StatSoft, 2008). It is possible to understand that neurons in a trained neural network behave as a function or formula in the overall algorithm. The entire and trained neural network can be a procedural algorithm to solve a problem in the computation.

Several brain imaging studies shown in Goodenough and Prehn's (2004) study suggested that neural substrata are associated with normative judgments, such as the ventromedial prefrontal cortex, orbitofrontal cortex, posterior cingulated cortex and posterior superior temporal sulcus. Activities such as the processing of information in the brain are explained as electrical or chemical actions of synapses in the physical level (Kandel, Schwartz, & Jessell, 2000; Bear, Connors, & Paradiso, 2006). So, it is possible to compare this process with the physical basis of computation. In the lowest level, the brain and nervous system behave as the hardware of computation and the flow of blood and electric stimulation in the brain and nervous system. It shows that there should be the level of physical basis on the moral functioning, represented by activities of the brain and nervous system.

Pros and Cons for Reductionism in Moral Thinking

Reductionism and moral psychology have been reviewed. With the concept of reduction, moral psychology would extend the level toward the lower and more biological layer. Kim (1996) suggested two

benefits of reduction from the viewpoint of philosophy. If the theory is properly reduced, it will provide explanations of reduced theory from the principles of a basic theory. An example of this is the principles of gas, such as Boyle's law, $PV = C$, where "P" is a pressure, "V" is a volume and "C" is a constant (Oxtoby, Gillis, & Nachtrieb, 2002), when the principles of gas are reduced with mechanical principles of particles that consist of the whole gas. Likewise, we can get more metaphysical benefits of ontological simplicity, if we explain the fact that gas has a temperature simply by the statement that gas has mean velocity and micro-molecular properties without further explanation.

This can be related to moral psychology. There are several benefits that can be obtained from the insight of the lower levels. Narvaez and Vaydich (2008) suggested that examining the current biological and neuroscientific knowledge about human behavior is similar to learning about the soil in which one grows plants. It would mean that learning about the neurobiological systems can help us understand difficulties that improve outcomes for human beings.

In contrast, there are some limitations in reductionism, such as the theoretical problems argued by Anderson (1972), Van Regenmortel (2004), Alm and Arkin (2003), who mainly pointed out the great increase in the complexity and quantity of explanation when we try to explain a phenomenon or theory into an excessively reduced form. For instance, if we reduce the copying of DNA (deoxyribonucleic acid) and the co-work of RNA (ribonucleic acid) in biology into concepts in chemistry, we should interpret the interactions among adenine, guanine, cytosine, thymine and uracil to chemical notations, such as the bonding of hydrogen, carbon, oxygen, nitrogen and other elements. Moreover, if we reduce it to equations of physics, we should introduce equations in classical dynamics to all molecules or elements that constitute the DNA or RNA (Tozern & Byers, 2004). In this process of reduction, we have to deal with an enormously increased amount of calculations, as the degree of reduction is increased.

In addition, we can concentrate upon more practical problems of reductionism. Brattico (2008) argued that even a simplified mind and thinking under reduced principles would be extremely inefficient because of the high complexity of the mind. It is possible to apply this to moral thinking in order to reduce moral thinking into the activation of the neurons and parts of the brain. However, it would be difficult due to the number of neural elements that attend to moral thinking to analyze. Van Regenmortel (2001) showed that approaches from the most reduced level would not be optimized (some experimental) and the higher level-based approaches would be more optimized and successful in vaccine development. It is not easy to explain the high-level structure of moral thinking just by discussing a combination of low-level physical structures, such as neural networks or areas of the brain.

From a medical perspective, Heng (2008) insisted that alternative strategies that not only focus on destroying cancer cells but also achieve the most possible cooperative and beneficial relationship to patients need to be developed. This is because clinical therapies have to balance the part of the system and the response of the patient as a whole. In addition to Heng (2008), Turner (2001) insisted that it would be true that at a lower-level the brain determines thoughts, feelings and behavior. However, feelings and thoughts determine behavior, which determines how the brain and body grow. It means that there is a co-development and close interaction between the levels that are not unidirectional toward the lower level.

This study suggests an overall and level-based approach towards moral psychology and education. It is not possible to use only the most reduced theory on moral thinking because of theoretical or practical problems and there is a need to approach it from all levels. Because human beings consist of multiple levels, from the

abstract-highest level to the physical-lowest level, the study or education of human moral thinking requires consideration of all levels. It is linked to the complexity of a system and, as Tuner (2001) argued, there is co-development among multiple levels. For instance, neurons and the brain determine moral thinking from the original level. However, the highest level, environment, social interaction and abstract thinking will develop to train the neural network, activation of the brain and genes. From a practical side, a more original and reduced theory of moral thinking could not be directly applied to real education. For example, the knowledge of brain activity and the neural network on morality might hardly give ideas of how to teach students to be moral to teachers in schools.

Consequently, we can apply the model of three levels to moral education or studies of moral psychology. In regular classes, abstract models of moral thinking can be applied. Since the highest level is linked to the lower levels, and in classes, even if we approach the lectures from the sole perspective of the highest level, it would be possible to improve students at every level with the knowledge of the level model and linkage of those levels. The second level of cognitive algorithm can be useful when we meet students who have cognitive disorders. To cope with these kinds of problems, it is possible to solve them with several medical or psychological treatments that deal with cognitive disorders. Last of all, at the lowest level, the brain or neurons can be introduced in both extraordinary and normal situations. In extraordinary situations, a student who has defects in the brain or nervous system cannot behave morally, even though there is no problem in abstract moral judgment, and in such a case, we can try to use neurosurgical methodology. Also, in normal situations, such as moral classes in schools, as Narvaez and Vaydich (2008) suggested, this would be linked to lessons teaching students how to create positive climates and relationships in class. In sum, in moral psychology and education, the application of solely reduced theory would not be useful, mainly because excessive reduction in moral psychology would increase the complexity of explanation and cost of analysis. Instead, the use of overall multiple-levels would be more helpful and realistic.

Finally, this study suggests further studies related to the topic of this study. First, further studies should try to find out the proper degree of reduction that can maximize the explanatory power of human moral thinking with minimal complexity and cost of analysis based on level-structure. Second, further studies will be needed to discover a practical methodology of how to introduce neuroscientific invention to moral education in schools. Lastly, to increase the explanatory power of moral psychology with as few side effects of reduction as possible, it would be necessary to introduce various backgrounds, such as sociobiology and social psychology in addition to neurobiology and the theoretical framework of moral thinking.

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